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Seluga et al.

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(54) **GOLF CLUB HEAD HAVING FACE STRESS-REDUCTION FEATURES**

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A63B 53/04 (2015.01)
A63B 53/06 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A63B 53/0466*** (2013.01); ***A63B 53/06*** (2013.01); ***A63B 60/04*** (2015.10);
(Continued)

(58) **Field of Classification Search**
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(Continued)

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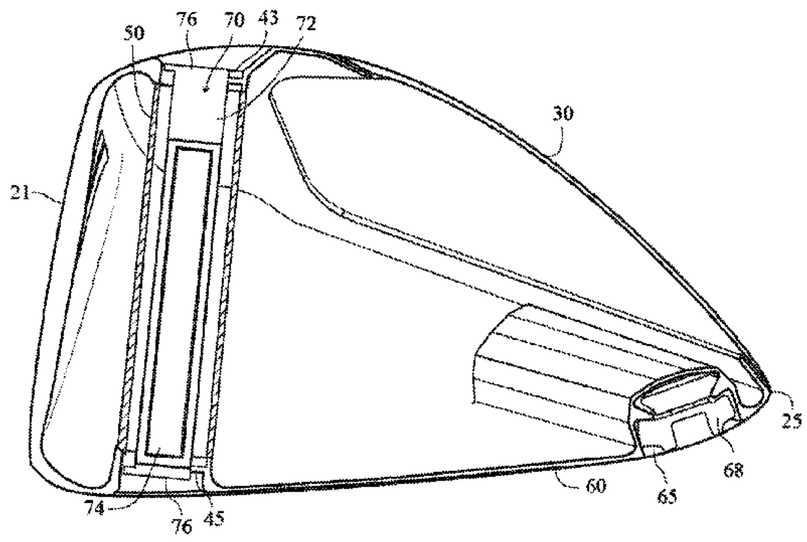
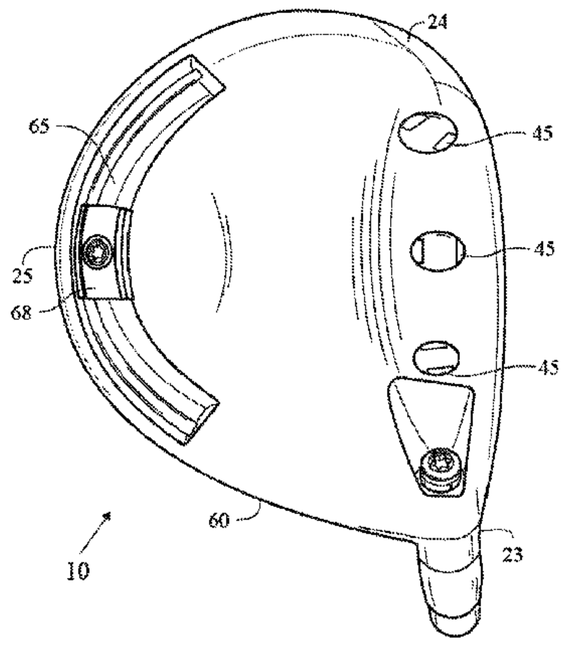
(57) **ABSTRACT**

A golf club head comprising a body, at least one weight cartridge, and a plurality of hollow tubes is disclosed herein. The body comprises a face section, a sole section, and a return section, and also defines a hollow interior. Each of the plurality of hollow tubes extends from the return section to the sole section to reduce stresses placed on the face during impact with a golf ball, and the at least one weight cartridge is sized to fit within at least one of the plurality of hollow tubes. The sole section and return section each comprise keyed apertures providing access to the hollow tubes with which they communicate, and the at least one weight cartridge comprises a keyed structure sized to fit through the keyed apertures.

16 Claims, 3 Drawing Sheets





Related U.S. Application Data

continuation-in-part of application No. 14/847,227, filed on Sep. 8, 2015, now Pat. No. 9,486,677, which is a continuation-in-part of application No. 14/788,326, filed on Jun. 30, 2015, now Pat. No. 9,597,558, and a continuation-in-part of application No. 14/794,578, filed on Jul. 8, 2015.

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USPC 473/324–350, 287–292, 313–314, 473/244–248

See application file for complete search history.

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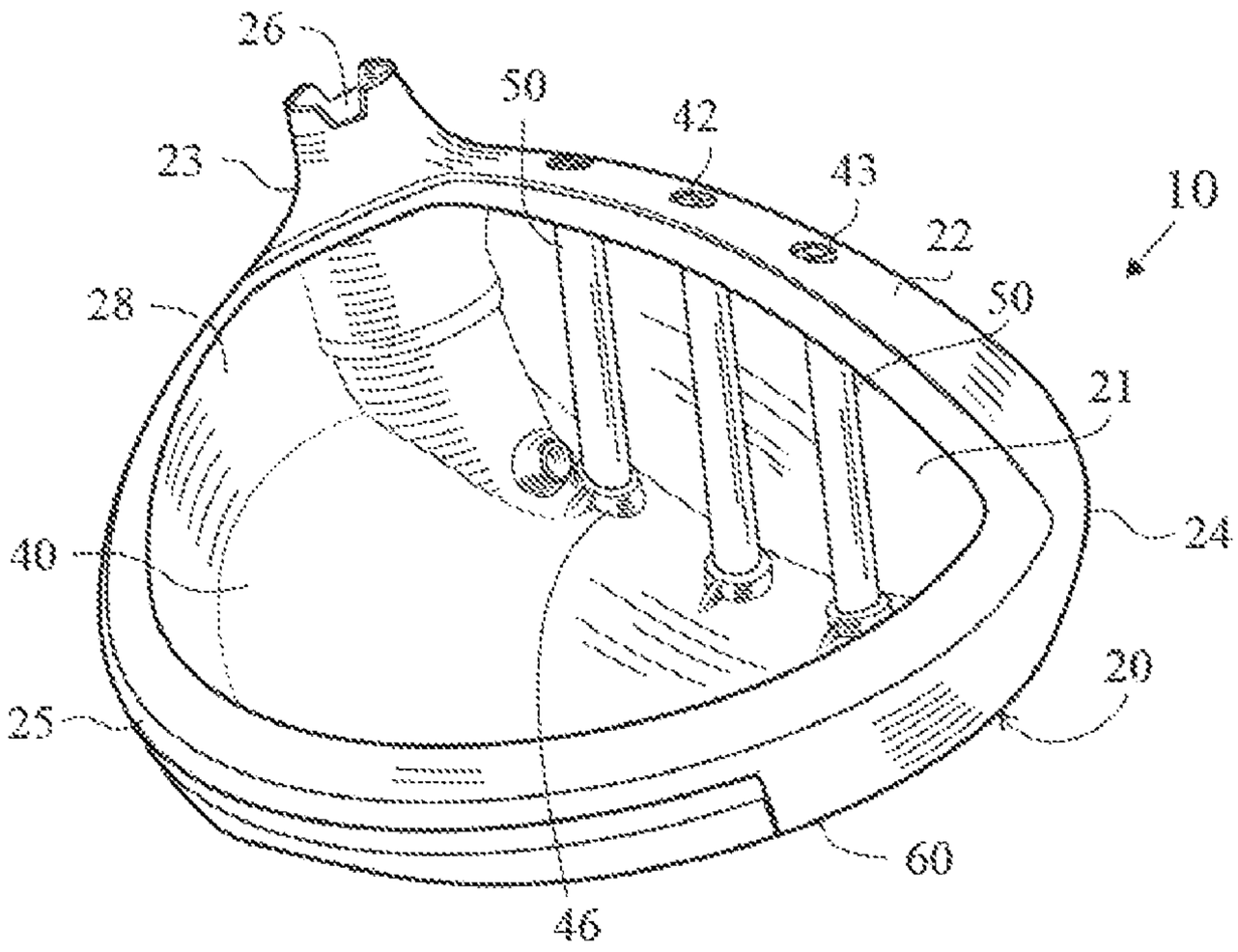
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FIG. 1

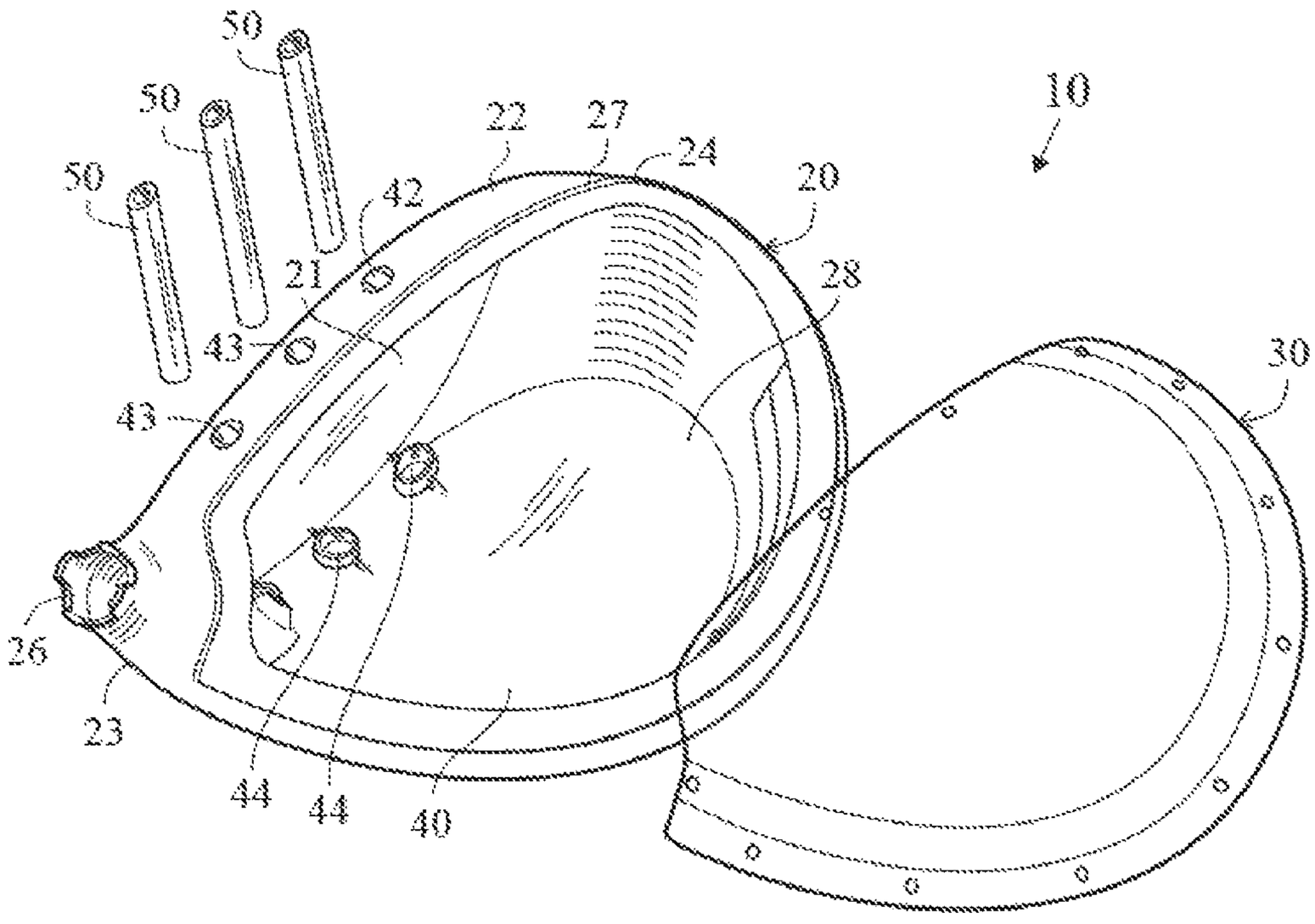
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FIG. 2

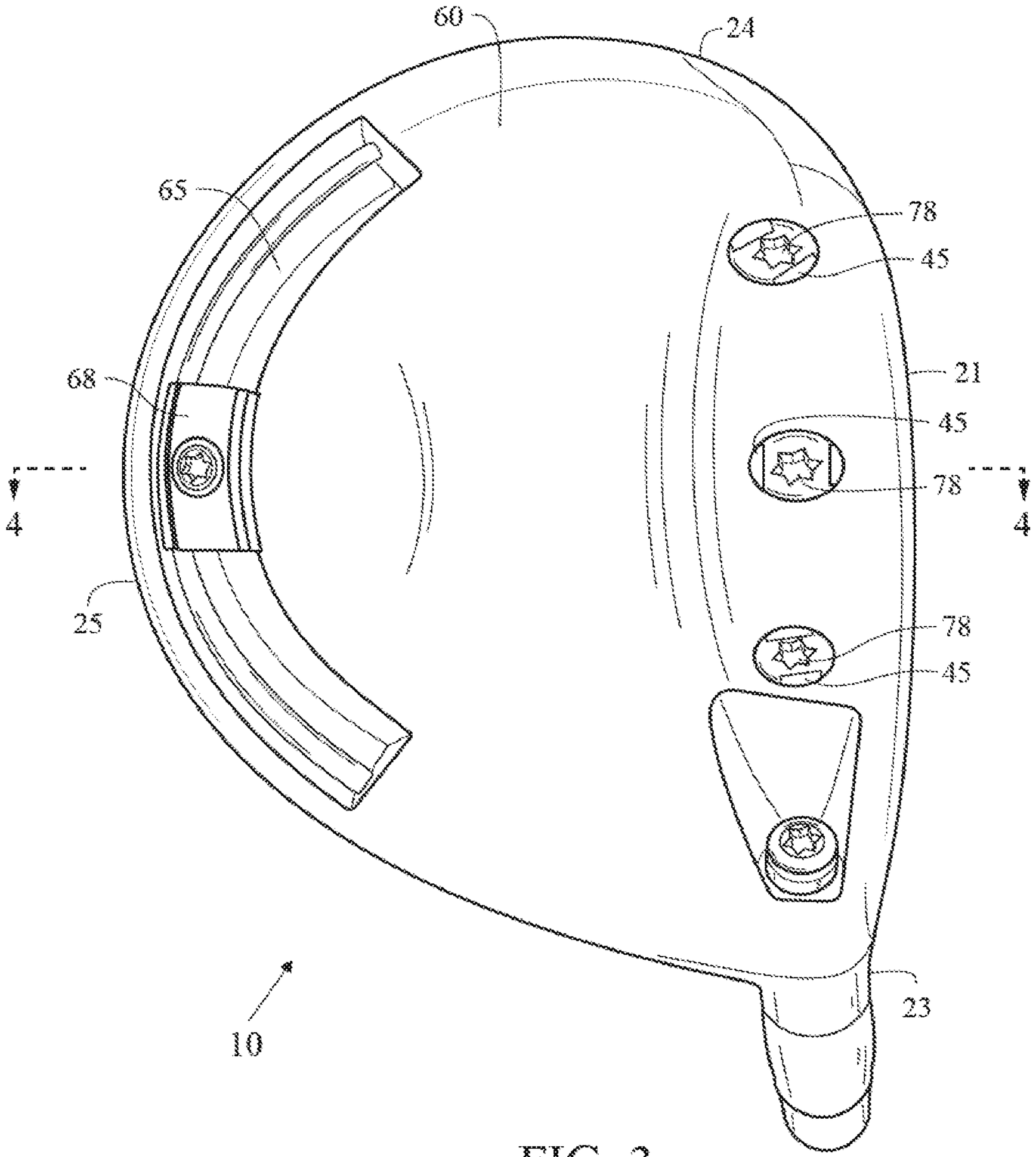

FIG. 3

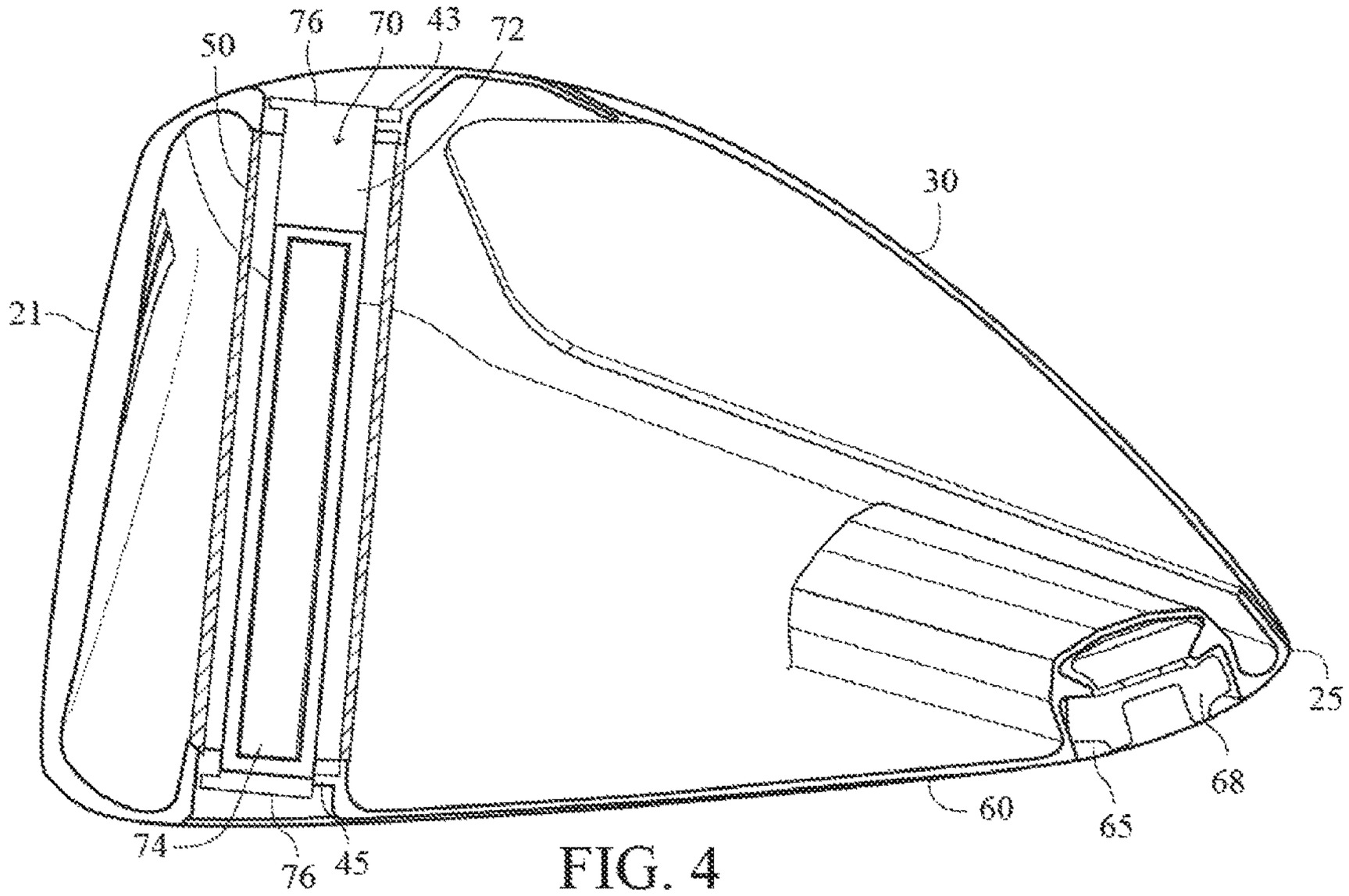

FIG. 4

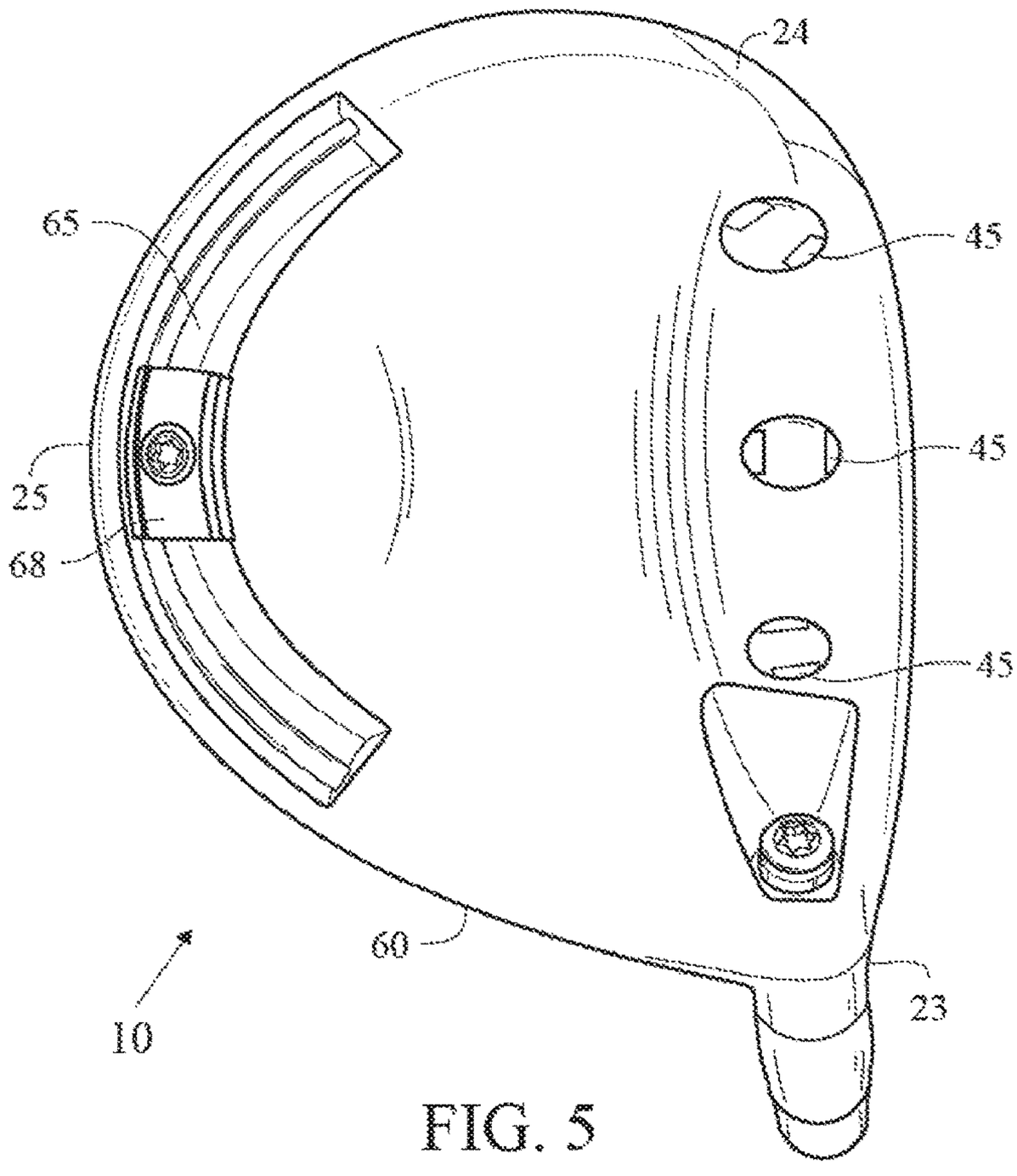

FIG. 5

GOLF CLUB HEAD HAVING FACE STRESS-REDUCTION FEATURES

CROSS REFERENCES TO RELATED APPLICATIONS

The present invention is a continuation of U.S. patent application Ser. No. 15/005,875, filed on Jan. 25, 2016, which is a continuation-in-part of U.S. patent application Ser. No. 14/847,227, filed on Sep. 8, 2015, which is a continuation-in-part of U.S. patent application Ser. No. 14/788,326, filed on Jun. 30, 2015, and is also a continuation-in-part of U.S. patent application Ser. No. 14/794,578, filed on Jul. 8, 2015, the disclosure of each of which is hereby incorporated by reference in its entirety herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a golf club head. More specifically, the present invention relates to a golf club head with stress-reduction tubes disposed proximate the face.

Description of the Related Art

The prior art discloses various golf club heads having interior structures. For example, Yabu, U.S. Pat. No. 6,852,038 for a Golf Club Head And Method OF Making The Same, discloses a golf club head with a sound bar, Galloway, U.S. Pat. No. 7,118,493 for a Multiple Material Golf Club Head discloses a golf club head with a composite aft body having an interior sound component extending upward from a sole section of a metal face component, Seluga et al., U.S. Pat. No. 8,834,294 for a Golf Club Head With Center Of Gravity Adjustability discloses a golf club head with a tube having a mass for adjusting the center of gravity (CG) of a golf club head, and Dawson et al., U.S. Pat. No. 8,900,070 for a Weighted Golf Club Head discloses a golf club head with an interior weight lip extending from the sole towards the face. However, the prior art fails to disclose an interior structure that increases ball speed by reducing stress in the face at impact, with a minimal increase in mass to the golf club head, while at the same time permitting vertical adjustment of CG location.

BRIEF SUMMARY OF THE INVENTION

The golf club head comprises interior tubes to reduce the stress in a face during impact with a golf ball. One aspect of the present invention is a golf club head comprising a body and a plurality of tubes. The body comprises a face section, a sole section and a crown section. The body defines a hollow interior. Each of the plurality of tubes extends from the crown section to the sole section proximate the face. Each of the tubes may be composed of composite or a high-strength metal such as steel or titanium, and may receive a narrow, cylindrical weight adjustment cartridge having a heavy end and a lightweight end and keyed locking features.

Another aspect of the present invention is a golf club head comprising a body comprising a striking face, a sole, and a return section, the body defining a hollow interior, a plurality of hollow tubes, each of the plurality of hollow tubes extending from the return section to the sole, and at least one weight cartridge sized to fit within at least one of the plurality of hollow tubes, wherein the return section comprises a first plurality of apertures, wherein the sole comprises a second plurality of apertures, wherein each of the first plurality of apertures corresponds to a hollow tube of the plurality of hollow tubes, wherein each of the second plurality of apertures corresponds to a hollow tube of the plurality of hollow tubes, and wherein each of the plurality of hollow tubes is disposed within 11 millimeters of an interior surface of the striking face. In some embodiments, each of the first plurality of apertures and the second plurality of apertures may comprise a keyed structure, the at least one weight cartridge may comprise at least one keyed cover sized to fit within the keyed structure, and rotating the at least one weight cartridge within a hollow tube may reversibly lock the at least one weight cartridge within the hollow tube.

In other embodiments, the plurality of hollow tubes may range from two to eight hollow tubes, or the sole may comprise a plurality of bosses, each of which may correspond to a hollow tube of the plurality of hollow tubes. In some embodiments, the at least one weight cartridge may comprise a heavy end, which may have a high-density weight, and a lightweight end. In some embodiments, each of the plurality of hollow tubes may have a length ranging from 30 millimeters to 60 millimeters, and each of the plurality of hollow tubes may be composed of a titanium alloy. The body may be composed of a titanium alloy, steel, or carbon composite, and the golf club head may further comprise a composite crown section. In any of the embodiments, the golf club head may have a volume ranging from 200 cubic centimeters to 475 cubic centimeters.

In some embodiments, the at least one weight cartridge may comprise three weight cartridges, the plurality of hollow tubes may comprise three hollow tubes, and each of the three weight cartridges may be disposed in one of the hollow tubes. In other embodiments, the golf club head may further comprise a slidable weight, the sole may comprise a channel, and the slidable weight may be disposed within the channel. In a further embodiment, the channel may comprise at least one rail, and the slidable weight may be reversibly affixed to the at least one rail with a mechanical fastener.

Yet another aspect of the present invention is a driver-type golf club head comprising a metal body comprising a striking face, a sole, and a return section, the body defining a hollow interior, a composite crown section, a plurality of hollow titanium tubes, each of the plurality of hollow titanium tubes extending from the return section to the sole, and at least one weight cartridge sized to fit within at least one of the plurality of hollow titanium tubes, wherein the return section comprises a first plurality of apertures, wherein the sole comprises a second plurality of apertures, wherein each of the first plurality of apertures corresponds to a hollow titanium tube of the plurality of hollow titanium tubes, wherein each of the second plurality of apertures corresponds to a hollow titanium tube of the plurality of hollow titanium tubes, wherein each of the first plurality of apertures and the second plurality of apertures comprises a keyed structure, wherein the at least one weight cartridge comprises a heavy end, a lightweight end, and at least one keyed cover sized to fit within the keyed structure, and wherein rotating the at least one weight cartridge within a hollow tube reversibly locks the at least one weight cartridge within the hollow tube.

In some embodiments, the plurality of hollow titanium tubes may range from two to eight hollow titanium tubes, and the sole may comprise a plurality of bosses, each of

which may correspond to a hollow titanium tube of the plurality of hollow titanium tubes. In other embodiments, each of the plurality of hollow titanium tubes may have a length ranging from 30 millimeters to 60 millimeters. In yet another embodiment, the striking face may comprise a variable thickness pattern.

Having briefly described the present invention, the above and further objects, features and advantages thereof will be recognized by those skilled in the pertinent art from the following detailed description of the invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a top perspective view of the golf club head of the present invention with a crown section removed to illustrate an interior.

FIG. **2** is a top perspective, exploded view of the golf club head shown in FIG. **1**.

FIG. **3** is a bottom elevational view of the golf club head shown in FIG. **1**.

FIG. **4** is a cross-sectional view of the golf club head shown in FIG. **3** along lines **4-4**.

FIG. **5** is a bottom elevational view of the golf club head shown in FIG. **3** with the weight cartridges removed.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIGS. **1-5**, a preferred embodiment of the golf club head **10** of the present invention is generally designated. The golf club head **10** preferably includes a body **20** having a striking face **21**, a return section **22**, a heel end **23**, a toe end **24**, an aft end **25**, a hosel **26**, a bond flange **27**, an upper opening **28**, and a sole **60**. A crown **30** is placed over an upper opening **28** in the body **20** and is permanently bonded to the body **20** along the bond flange **27** so that the crown **30** is flush with the return section **22**. The body **20**, along with the crown **30**, preferably defines a hollow interior **40**. Within the hollow interior, multiple hollow tubes **50** extend from the sole **60** upward to the return section **22**.

The plurality of tubes **50** preferably comprises two to eight tubes. Each of the plurality of tubes **50** preferably has a diameter ranging from 2 to 5 millimeters and a length ranging from 30 to 60 millimeters. Each of the plurality of tubes **50** is preferably positioned within 11 millimeters of an interior surface of the striking face **21**. The mass of each of the plurality of tubes **50** preferably ranges from 0.5 to 3 grams, more preferably from 1 to 2 grams, and most preferably each tube **50** has a mass of 1.5 grams.

The return section **22** preferably comprises a plurality of apertures **42**, each of which preferably corresponds to a tube **50** of the plurality of tubes **50**. The sole **60** also comprises a plurality of apertures **44**, each leading to a boss **46** that extends into the hollow interior **40** of the body **20** and which preferably corresponds to a tube **50** of the plurality of tubes **50**. The tubes **50** are preferably affixed in the bosses **46** via bonding if the tubes **50** are made of carbon composite and via welding if the tubes **50** are made of a metal such as titanium or steel.

Each of the hollow tubes **50** is sized to receive a narrow weight cartridge **70**, such as the one shown in FIG. **4**. The weight cartridge **70** may have any of the features disclosed in U.S. Pat. Nos. 8,834,294 and 9,067,110, the disclosure of each of which is incorporated by reference in its entirety herein, but at the very least the weight cartridge **70** preferably has a heavy end **72** comprising a high-density weight and a lightweight end **74**, each of which has a keyed, cam-shaped cover feature **76** with a tool-engaging structure **78**. Each of the apertures **42**, **44** in the body has a keyed structure **43**, **45** sized to receive the keyed, cam-shaped cover feature **76** and to allow it to lock when a golfer uses a tool (not shown) to engage the tool-engaging structure **78** and rotate the weight cartridge **70** within the tube **50**. The keyed, cam-shaped cover features **76** and the keyed structures **43**, **45** may have any of the structures, and interact in any of the ways, described in U.S. patent application Ser. No. 14/216,971 and Ser. No. 14/823,834, the disclosure of each of which is incorporated by reference in its entirety herein.

In the preferred embodiment, a weight cartridge **70** is provided for each of the tubes **50** in the golf club head **10**, but in an alternative embodiment, only one weight cartridge **70**, which can fit in each of the plurality of tubes **50**, is provided, and the golf club head **10** includes covers (not shown) for the apertures **42**, **44** leading to unfilled tubes **50** so that no debris gets into the tubes **50** when the golf club head **10** is in use.

As shown in the Figures, the sole **60** comprises a channel **65** extending proximate the aft end **25** between the heel end **23** and the toe end **24** of the golf club head **10**. The channel **65** is sized to receive a slidable weight **68**. The channel **65** and slidable weight **68** may have any of the characteristics, dimensions, and functionality of the embodiments disclosed in U.S. Pat. Nos. 8,696,491, 8,894,506, 9,084,921, and 9,211,453, the disclosure of each of which is incorporated by reference in its entirety herein, or in U.S. patent application Ser. Nos. 14/174,068, 14/175,657, 14/216,971, 14/884,027, and Ser. No. 14/933,973, the disclosure of each of which is also incorporated by reference in its entirety herein.

In a preferred embodiment, the striking face **21** has a varying thickness such as described in U.S. Pat. No. 7,448,960, for a Golf Club Head With Variable Face Thickness, which pertinent parts are hereby incorporated by reference. Other alternative embodiments of the thickness of the striking face **21** are disclosed in U.S. Pat. No. 6,398,666, for a Golf Club Striking Plate With Variable Thickness, U.S. Pat. No. 6,471,603, for a Contoured Golf Club Face and U.S. Pat. No. 6,368,234, for a Golf Club Striking Plate Having Elliptical Regions Of Thickness, all of which are owned by Callaway Golf Company and which pertinent parts are hereby incorporated by reference. Alternatively, the face section has a uniform thickness.

The body **20** is preferably cast from molten metal in a method such as the well-known lost-wax casting method. The metal for casting is preferably titanium or a titanium alloy such as 6-4 titanium alloy, alpha-beta titanium alloy or beta titanium alloy for forging, and 6-4 titanium for casting. Alternatively, the body **20** is composed of 17-4 steel alloy. Additional methods for manufacturing the body **20** include forming the body **20** from a flat sheet of metal, super-plastic forming the body from a flat sheet of metal, machining the body **20** from a solid block of metal, electrochemical milling the body **20** from a forged pre-form, casting the body using centrifugal casting, casting the body **20** using levitation casting, and like manufacturing methods. Alternatively, the body **20** may be formed from a carbon composite material, including any of the materials disclosed in U.S. Pat. No. 9,033,822, the disclosure of which is incorporated by reference in its entirety herein.

The golf club head **10**, when designed as a driver, preferably has a volume from 200 cubic centimeters to 600 cubic centimeters, more preferably from 300 cubic centi-

meters to 500 cubic centimeters, and most preferably from 420 cubic centimeters to 470 cubic centimeters, with a most preferred volume of 460 cubic centimeters. The volume of the golf club head **10** will also vary between fairway woods (preferably ranging from 3-woods to eleven woods) with smaller volumes than drivers.

The golf club head **10**, when designed as a driver, preferably has a mass no more than 215 grams, and most preferably a mass of 180 to 215 grams. When the golf club head **10** is designed as a fairway wood, the golf club head preferably has a mass of 135 grams to 200 grams, and preferably from 140 grams to 165 grams.

A preferred embodiment of the golf club head **10** has a volume of 460 cubic centimeters with the Characteristic Time (CT) of the face close to, but not exceeding 257 microsecond ("μS") limit set by the USGA.

In other embodiments, the golf club head **10** may have a multi-material composition such as any of those disclosed in U.S. Pat. Nos. 6,244,976, 6,332,847, 6,386,990, 6,406,378, 6,440,008, 6,471,604, 6,491,592, 6,527,650, 6,565,452, 6,575,845, 6,478,692, 6,582,323, 6,508,978, 6,592,466, 6,602,149, 6,607,452, 6,612,398, 6,663,504, 6,669,578, 6,739,982, 6,758,763, 6,860,824, 6,994,637, 7,025,692, 7,070,517, 7,112,148, 7,118,493, 7,121,957, 7,125,344, 7,128,661, 7,163,470, 7,226,366, 7,252,600, 7,258,631, 7,314,418, 7,320,646, 7,387,577, 7,396,296, 7,402,112, 7,407,448, 7,413,520, 7,431,667, 7,438,647, 7,455,598, 7,476,161, 7,491,134, 7,497,787, 7,549,935, 7,578,751, 7,717,807, 7,749,096, and 7,749,097, the disclosure of each of which is hereby incorporated in its entirety herein.

From the foregoing it is believed that those skilled in the pertinent art will recognize the meritorious advancement of this invention and will readily understand that while the present invention has been described in association with a preferred embodiment thereof, and other embodiments illustrated in the accompanying drawings, numerous changes, modifications and substitutions of equivalents may be made therein without departing from the spirit and scope of this invention which is intended to be unlimited by the foregoing except as may appear in the following appended claims. Therefore, the embodiments of the invention in which an exclusive property or privilege is claimed are defined in the following appended claims.

We claim:

1. A golf club head comprising:

a body comprising a striking face, a sole, and a return section, the body defining a hollow interior, and the sole and return section defining an upper opening;

a plurality of titanium tubes, each of the plurality of titanium tubes extending within the hollow interior from the return section to the sole;

a crown section sized to cover the upper opening; and

at least one weight cartridge sized to fit within at least one of the plurality of titanium tubes,

wherein the plurality of titanium tubes ranges from two to eight titanium tubes,

wherein the sole comprises a plurality of bosses,

wherein each of the plurality of bosses corresponds to a titanium tube of the plurality of titanium tubes,

wherein each of the plurality of titanium tubes has a length ranging from 30 millimeters to 60 millimeters,

wherein each of the plurality of titanium tubes is disposed within 11 millimeters of an interior surface of the striking face,

wherein the plurality of titanium tubes increases ball speed by reducing stress placed on the striking face during impact with a golf ball, and

wherein the striking face has a characteristic time that is close to, but does not exceed, 257 microseconds.

2. The golf club head according to claim **1**, wherein the return section comprises a first plurality of apertures, wherein the sole comprises a second plurality of apertures, wherein each of the first plurality of apertures corresponds to a titanium tube of the plurality of titanium tubes, and wherein each of the second plurality of apertures corresponds to a titanium tube of the plurality of hollow tubes.

3. The golf club head according to claim **2**, wherein each of the first plurality of apertures and the second plurality of apertures comprises a keyed structure, wherein the at least one weight cartridge comprises at least one keyed cover sized to fit within the keyed structure, and wherein rotating the at least one weight cartridge within a titanium tube of the plurality of titanium tubes reversibly locks the at least one weight cartridge within the titanium tube.

4. The golf club head according to claim **1**, wherein the at least one weight cartridge comprises a heavy end and a lightweight end.

5. The golf club head according to claim **4**, wherein the heavy end comprises a high-density weight.

6. The golf club head according to claim **1**, wherein the body is composed of material selected from the group consisting of titanium alloy and steel.

7. The golf club head according to claim **6**, wherein each of the plurality of titanium tubes is welded to the body.

8. The golf club head according to claim **1**, wherein the crown section is composed of a composite material.

9. The golf club head according to claim **1**, wherein the golf club head has a volume ranging from 200 cubic centimeters to 475 cubic centimeters.

10. The golf club head according to claim **1**, wherein the body is composed of carbon composite material.

11. The golf club head according to claim **1**, wherein the at least one weight cartridge comprises three weight cartridges, wherein the plurality of titanium tubes comprises three titanium tubes, and wherein each of the three weight cartridges is disposed, respectively, in one of the three titanium tubes.

12. The golf club head according to claim **1**, further comprising a slidable weight, wherein the sole comprises a channel, and wherein the slidable weight is disposed within the channel.

13. The golf club head according to claim **12**, wherein the channel comprises at least one rail, and wherein the slidable weight is reversibly affixed to the at least one rail with a mechanical fastener.

14. A driver-type golf club head comprising:

a metal body comprising a striking face, a sole, and a return section, the body defining a hollow interior, the return section and sole defining an upper opening;

a composite crown section sized to close the upper opening;

a plurality of titanium tubes, each of the plurality of titanium tubes extending from the return section to the sole proximate an interior surface of the striking face; and

a weight cartridge sized to fit within at least one of the plurality of titanium tubes,

wherein the striking face comprises a variable thickness pattern,

wherein each titanium tube of the plurality of titanium tubes is welded to the body,

wherein the weight cartridge comprises a heavy end and a lightweight end,

wherein the plurality of titanium tubes ranges from two to eight titanium tubes,

wherein the sole comprises a plurality of bosses,

wherein each of the plurality of bosses corresponds to a titanium tube of the plurality of titanium tubes,

wherein each of the plurality of hollow titanium tubes has a length ranging from 30 millimeters to 60 millimeters and a diameter ranging from 2 millimeters to 5 millimeters,

wherein the plurality of titanium tubes increases ball speed by reducing stress placed on the striking face during impact with a golf ball, and

wherein the striking face has a characteristic time that is close to, but does not exceed, 257 microseconds.

15. The golf club head according to claim **14**, wherein the return section comprises a first plurality of apertures, wherein the sole comprises a second plurality of apertures, wherein each of the first plurality of apertures corresponds to a titanium tube of the plurality of titanium tubes, and wherein each of the second plurality of apertures corresponds to a titanium tube of the plurality of titanium tubes.

16. The golf club head according to claim **15**, wherein each of the first plurality of apertures and the second plurality of apertures comprises a keyed structure, wherein the weight cartridge comprises at least one keyed cover sized to fit within the keyed structure, and wherein rotating the weight cartridge within a titanium tube reversibly locks the weight cartridge within that titanium tube.

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